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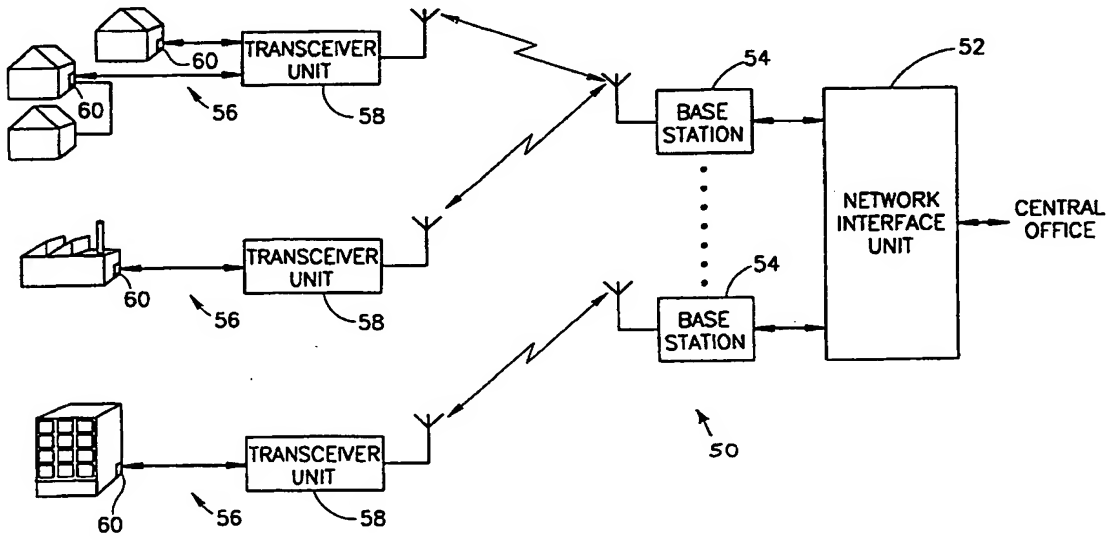

(57) Abstract

A remote terminal for a wireless local loop system comprising: a radio transceiver unit which receives signals from and sends signals to a base station for connection to a telecommunication network; and at least one service unit which receives signals from and sends signals via land lines to a plurality of subscribers, said service unit and said radio transceiver unit being situated at different sites, wherein a particular service unit is connected to a plurality of subscribers and said radio transceiver unit and said particular service unit are electrically connected by only a single pair of wires.

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WIRELESS LOCAL LOOP SYSTEM

FIELD OF THE INVENTION

The present invention is related to wireless local loop telephone systems and in particular to the configuration and installation of such systems.

BACKGROUND OF THE INVENTION

Wireless local loop (WLL) systems are well known in the art. One configuration of such a prior art system 10 is shown in Fig. 1A. In general such systems comprise one or more base station units 12, which are connected to a central office via a network interface unit 14. System 10 also includes one or more remote terminals 16. Remote terminals 16 receive radio transmissions from the base station and distribute messages to subscribers 18 via land lines 19. The remote terminals generally comprise an outdoor unit 20 which receives radio signals from and transmits signals to the base station and an indoor unit 22 which distributes telephone signals to the subscribers based on the radio signals. Indoor unit 22 thus acts as a small switchboard and the transceiver replaces the land lines which would otherwise connect the subscriber to the central office. Where multiple subscribers are supplied by a single remote station, the indoor unit is generally on the premises of one of the subscribers and is powered from the mains at the subscriber.

Installation of such systems is often problematic. As is evident, there are no lines connecting the remote stations to the central office. Thus, the central office cannot supply power to the remote stations. The remote stations must thus be powered directly from the local power lines. Two basic configurations are available for powering such systems, which are generally divided into an indoor unit and an outdoor unit. While these designations are descriptive of normal installation, the indoor unit could be mounted outdoors, if it is sufficiently weatherproofed, and occasionally is mounted on the same roof or telephone pole as the outdoor unit.

Fig. 1B shows the configuration of one such prior art remote terminal 16'. Remote terminal 16' comprises an indoor unit 20' and an outdoor unit 22'. Most of remote terminal 16' is comprised in indoor unit 20'. Indoor unit 20' produces an RF signal which is transported via a coaxial cable 24 to outdoor unit 22'. Optionally, the coaxial cable also carries power to an optional RF amplifier 26, situated in outdoor unit 22'.

While such systems have the advantage that most of the unit is indoors, they have the disadvantage that coaxial cables must be installed between the indoor and the outdoor units, i.e., between the outdoor installation and one of the subscribers. Coaxial cables are relatively

expensive and are more difficult to install than simple two-wire twisted pair lines. The distance between the indoor and the outdoor units is limited by the attenuation of the cable.

A second prior art remote terminal 16" is shown in Fig. 1C. Remote terminal 16" is also divided into an indoor unit 20" and an outdoor unit 22". However, indoor unit 20" includes only a power supply and an optional back-up battery. The subscriber connections are individually fed directly to outdoor unit 22" and power is supplied to outdoor unit 22" from indoor unit 20" via a twisted pair of wires. Thus, this installation utilizes easily installed of wire pairs between the outdoor unit and the indoor unit/subscribers. However, multiple sets of wire pairs are required to complete the installation. This is not always convenient, especially if there are a large number of lines being serviced by the remote terminal.

In some systems the power for the outdoor unit is supplied directly from mains to the unit. In other systems, a backup battery is present in the outdoor unit.

For some of such systems, when power is cut off at the subscriber in whose premises the indoor unit is installed, all of the subscribers lose their service.

SUMMARY OF THE INVENTION

One aspect of some embodiments of the present invention is the provision of a remote terminal in which a first unit, generally installed outdoors, is connected to a second unit, not co-located with the first unit and generally installed indoors, utilizing only a single pair of wires which is not a coaxial cable. Such a pair of wires may, for example, be a twisted pair. Such a system provides for easy installation. As used herein the term "pair of wires" excludes a coaxial cable.

Preferably, in accordance with a preferred embodiment of the invention, a remote terminal which services a number of subscribers is powered from the mains or from an external DC power source. In this aspect of the invention, power is supplied to the system from some or all of the subscribers. When power fails at one of the subscribers, the system continues to operate from power supplied by the other subscribers.

In a preferred embodiment of the invention, the remote terminal comprises a radio transceiver unit, which is mounted outdoors, adjacent to an antenna, and a service unit which is generally mounted indoors. A service unit is generally provided for each subscriber or group of subscribers located in a single installation or in nearby installations and is powered by mains power supplied by the subscriber or from a DC power source. A single pair of wires connects the service and radio transceiver units and carries digital or analog telephone signals (which way be multiplexed signals from a plurality of user terminals and/or subscribers) and also

carries power from the service unit to power the radio transceiver. Preferably, each service unit or an associated backup power source supplies power to the radio transceiver unit such that radio transceiver unit remains powered even if one or more of the service units becomes inactive.

In another aspect of the invention, a single pair of wires, preferably a twisted pair of conductors, between the service unit and the radio transceiver supplies at least two and preferably three of the following functions: 1) transfer of telephony signals and associated signaling (in accordance with a recognized protocol); 2) power from the service unit to the radio transceiver unit; and, 3) remote station control information which is not directly related to the telephony signal, for example, a control signal between the units which tests one or the other units or transmits status reports on the "health" of the system or which provides status information, as for example, the ability to monitor the operation of non-subscriber hardware, as desired. As used herein, the term remote station control information shall have the meaning as described in this paragraph.

There is thus provided, in accordance with a preferred embodiment of the invention, a remote terminal for a wireless local loop system comprising;

a radio transceiver unit which receives signals from and sends signals to a base station for connection to a telecommunication network; and

at least one service unit which receives signals from and sends signals via land lines to a plurality of subscribers, said service unit and said radio transceiver unit being situated at different sites, wherein

a particular service unit is connected to a plurality of subscribers and said radio transceiver unit and said particular service unit are electrically connected by only a single pair of wires.

In a preferred embodiment of the invention the service unit is powered by a source of energy and power for the radio transceiver unit is transmitted to the radio transceiver unit from the service unit via the single pair of wires.

Preferably, the at least one service unit comprises a plurality of service units. Preferably, at least two service units are individually powered by energy sources and power for the radio transceiver unit is transmitted thereto from the service units via the single pair of wires from each of a plurality of service units.

Preferably, the transceiver unit comprises circuitry which receives signals from the plurality of service units, multiplexes the signals and sends the multiplexed signals to the base

station. Preferably, the transceiver unit comprises circuitry which receives multiplexed signals from the base station and at least partially demultiplexes the signals prior to sending the at least partially demultiplexed signals to the service units.

Preferably, the service unit includes circuitry which receives signals from said plurality of subscribers and multiplexes said signals prior to sending the multiplexed signals to the radio transceiver unit.

Preferably, the service unit includes circuitry which receives multiplexed signals from the radio transceiver unit and demultiplexes the signals prior to distributing signals to the plurality of subscribers.

In a preferred embodiment of the invention, at least one service unit supplies ISDN service to a subscriber. Alternatively, or additionally, at least one service unit provides data services and/or other telephony services to a subscriber.

There is further provided, in accordance with a preferred embodiment of the invention a remote terminal for a wireless local loop system comprising:

a radio transceiver unit which receives signals from and sends signals to a base station for connection to a telecommunication network; and

at least one service unit which receives signals from and sends signals via land lines to at least one subscriber, said service unit and said radio transceiver unit being situated at different sites, wherein

said radio transceiver unit and a particular service unit are electrically connected by a single pair of wires which carries at least two of:

(1) telephony signals and signaling in accordance with a standard protocol;

(2) power from the service unit to the radio transceiver unit; and

(3) control and management information indicating at least the status of non-subscriber equipment.

In a preferred embodiment of the invention, the pair of wires carries at least (1) and (2).

In a preferred embodiment of the invention, the pair of wires carries at least (1) and (3).

In a preferred embodiment of the invention, the pair of wires carries at least (2) and (3).

In a preferred embodiment of the invention, the pair of wires carries (1), (2) and (3).

Preferably, the radio transceiver unit and a particular service unit are electrically connected by only a single pair of wires.

In a preferred embodiment of the invention, the at least one service unit comprises a plurality of service units. Preferably, at least two service units are individually powered by

energy sources and wherein power for the radio transceiver unit is transmitted to the radio transceiver unit from the service units via a pair of wires from each of a plurality of service units.

Preferably, the pair of wires is a twisted pair.

There is further provided, in accordance with a preferred embodiment of the invention, a wireless local loop system comprising:

at least one remote station according to the invention; and

a base station which receives signals from the at least one remote station and passes the signals on to the telecommunication network.

Preferably, the at least one remote station comprises a plurality of said remote stations.

SHORT DESCRIPTION OF THE DRAWINGS

The invention will be more clearly understood from the following preferred embodiments thereof, taken together with the following drawings in which:

Fig. 1A is a schematic representation of a configuration of a wireless local loop (WLL) system of the prior art;

Fig. 1B is a schematic representation of a configuration of a prior art WLL remote terminal;

Fig. 1C is a schematic representation of a configuration of a second prior art WLL remote terminal;

Fig. 2 is a schematic representation of a configuration of a WLL system according to a preferred embodiment of the present invention;

Figs. 3A and 3B is a schematic representation of a configuration of a WLL remote terminal in accordance with a preferred embodiment of the present invention;

Fig. 4 is a schematic representations of circuitry for the juxtapositioning of digital signals and power, at a service unit, for transfer over a pair or wires, in accordance with a preferred embodiment of the invention.; and

Fig. 5 is a schematic representation of a system for powering a radio transceiver unit of a WLL remote terminal, in accordance with a preferred embodiment of the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 2 is a schematic representation of a wireless local loop (WLL) telecommunication system 50 in accordance with a preferred embodiment of the present invention. System 50 comprises a network interface unit 52 which is connected to a telecommunications network (not shown). Interface unit 52 serves to connect at least one base station 54 to the network. Base

station 54 and network interface unit 52 are generally conventional and may be of any construction as is known in the art. They interface with the telecommunications network and with remote terminals (described below in detail) in a purely conventional manner. No further description of base stations 52 and interface unit 54 (which are sometimes packaged together and sometimes separately) is necessary for an understanding of the invention.

WLL system 50 also includes at least one and generally a plurality of remote terminals 56. Each base station 54 services one or more remote terminals 56 as shown in Fig. 2.

In a preferred embodiment of the invention, each remote terminal 56 includes a radio transceiver unit 58 and one or more service units 60. The number of service units 60 associated with a given remote station will depend on the particular mix of subscribers being serviced by the remote station. Typically, a service unit can service a number of separate subscribers in an apartment house, a single residence or two of more relatively nearby residences, a factory or office building, etc., depending on the number of lines required and the distance between the subscribers.

A schematic of a typical remote terminal is shown in Figs. 3A and 3B. The remote terminal, includes radio transceiver unit 58 (Fig. 3B) and a plurality of service units 60 (Fig. 3A). Each service unit 60 comprises one or more terminal interfaces 62 which connect directly to telephones or other subscriber equipment. Generally, each interface 62 is associated with a unique telephone number. In preferred embodiments of the invention, terminal interfaces 62 supply ISDN service to subscribers, and a plurality of telephone numbers are associated with each terminal interface. Alternatively or additionally, data services may be provided.

Additionally, each service unit 60 has a preferably digital interface 64 which connects, via a pair of wires, preferably a twisted pair 66, to a transceiver 67 in its associated radio transceiver unit 58. As described below, power is also supplied from one or more of service units 60 to radio transceiver unit 58 via twisted pair 66.

Figs. 3A and 3B show a typical configuration of a division of functions in a remote terminal 56 which allows for an especially simple connection between service units 60 and radio transceiver 58. However, other configurations and functional divisions allowing for this simple connection between the two units will occur to persons of skill in the art.

As shown in the particular configuration of Figs. 3A and 3B, each service unit 60 comprises, in addition to a plurality of terminal interfaces 62, an information decoding and encoding module 68 which receives signals from, and sends signals to the terminal interfaces, under control of a control unit 70. Module 68 sends signals to and receives signals from digital

interface 64 for interaction with radio transceiver unit 58. Generally module 68 receives multiplexed signals from digital interface 64, demultiplexes them and sends the individual telephone signals to the subscribers via terminal interfaces 62. It receives signals from the individual subscribers, again, via terminal interfaces 62, and multiplexes them for transmission, via digital interface 64 and twisted pair 66 to radio transceiver unit 58. This transmission may be by any high speed transmission known in the art such as 2B1Q, 4B3T, TCM (Time Compression Multiplexing) or other HDSL modem technology. Timing, control and management signals are also preferably sent, multiplexed with the telephony signals, on the pair of wires.

The design of the various units within service unit 60 may take any number of forms and may be purely conventional in nature. Alternatively, the form of the connection between the subscriber units and the pair of wires which carries the digital telephone information to and from the radio transceiver unit may differ from that shown and may, for example, be embodied in a computer and associated software and firmware. In preferred embodiments of the invention, however, the interface between the service unit and its associated radio transceiver unit is a single pair of wires.

Service unit 60 also preferably includes a power supply 72, which is mains supplied and optionally, a backup battery 74 which supplies power to the system when the mains power is not available. Power from power supply 72 preferably supplies power to the other elements of service unit 60 as well as delivering power to unit 58 via pair 66.

Alternatively or additionally, pair 66 also carries signaling, control and management information. For example such information may include information regarding the status of non-subscriber equipment, control and management of that equipment and other signals not normally part of the established telephony protocols. Preferably, the components of units 58 and 60 are designed and configured to provide such information. The design of equipment which provides status information is well known in the art.

Referring additionally to Fig. 4 shows a circuit 71 for the juxtaposition of the power with the digital signal outputs of digital interface 64. In this system power supply 72 provides an AC or DC power voltage to pair 66. This power voltage is superimposed on digital signals received from digital interface 64 in a transformer 76. A capacitor 78 assures that the transfer of information between service unit 60 and radio transceiver unit 58 is not effected by the presence or absence of power supply 72. It also assures that power supply 72 is undisturbed by signals transmitted on pair 66. Additional elements, such as inductors, may be provided, for example

between capacitor 78 and power supply 72 to provide cleaner DC power and/or better isolation of the power supply from pair 66.

Returning again to Fig. 3, Radio transceiver unit 58 preferably includes an antenna 80 which sends and receives radio frequency signals to and from its associated base station. When signals are to be sent, logic circuitry 81 assembles (multiplexes) signals received from transceivers 67 and sends them to the antenna via TX signal processing circuitry 82, TX RF modulating circuitry 84, T/R switch 86 and optional RF amplifier 88. When signals are to be received, logic circuitry 81 receives signals from the antenna via optional amplifier 88, T/R switch 86, RX demodulating circuitry 90, RX signal processing circuitry 92. After receipt of signals from circuitry 92, logic circuitry 81 distributes such signals after demultiplexing, to transceivers 67 for transmission to the various service units 60.

The design of the various units within radio transceiver unit 58 may take any number of forms and may be purely conventional in nature. Alternatively, logic circuitry 81 and/or portions of transceiver unit 58 that form of the connection between the subscriber units and the pair of wires which carries the digital telephone information to and from the radio transceiver unit may differ from that shown and may, for example, be embodied in a computer and associated software and firmware.

Radio transceiver unit 58 also includes a power supply or distribution unit 94 which provides power to the various units of radio transceiver unit 58. In a preferred embodiment of the invention, power supply or distribution unit 94 receives its energy via pair 66 from at least one of service units 60.

Fig. 5 shows one embodiment of circuitry 95 for separating the information signals and the power which were imposed on pair 66 by the circuitry shown in Fig. 4. In the circuitry of Fig. 5, a transformer 96 receives both the information signals and the power signals via pair 66. A power output 98 conducts the power voltage from transformer 96 to power supply or distribution unit 94. A capacitor 100 serves the same function as capacitor 78 in Fig. 4. A diode bridge 75 is preferably added to avoid problems which may result if the polarity of the DC power voltage is reversed. If AC power input is used, the bridge may be omitted or it may be used to rectify the power for use by supply 94. Where power is supplied by more than one set of pairs 66, unit 94 takes power from one or more of the pairs of wires. However, when one or more of the service units 58 loses power, radio transceiver unit 60 continues to operate and serve the other service units.

It should be understood that the arrangements of Figs. 4 and 5 are exemplary in nature and that many different ways of transferring power on pairs of wires 66 are useful in various aspects and embodiments of the invention.

The present invention has been described with reference to a preferred, non-limiting embodiment thereof. Variations of this embodiment, within the scope of the claims, which define the invention, will occur to persons of skill in the art.

CLAIMS

1. A remote terminal for a wireless local loop system comprising:

a radio transceiver unit which receives signals from and sends signals to a base station for connection to a telecommunication network; and

at least one service unit which receives signals from and sends signals via land lines to a plurality of subscribers, said service unit and said radio transceiver unit being situated at different sites, wherein

a particular service unit is connected to a plurality of subscribers and wherein said radio transceiver unit and said particular service unit are electrically connected by only a single pair of wires.

2. A remote terminal according to claim 1 wherein the service unit is powered by a source of energy and wherein power for the radio transceiver unit is transmitted to the radio transceiver unit from the service unit via said single pair of wires.

3. A remote terminal according to claim 1 or claim 2 wherein the at least one service unit comprises a plurality of service units.

4. A remote terminal according to claim 1 wherein the at least one service unit comprises a plurality of service units and wherein at least two service units are individually powered by energy sources and wherein power for the radio transceiver unit is transmitted to the radio transceiver unit from the service units via said single pair of wires from each of a plurality of service units.

5. A remote terminal according to claim 3 or claim 4 wherein the transceiver unit comprises circuitry which receives signals from the plurality of service units, multiplexes the signals and sends the multiplexed signals to the base station.

6. A remote terminal according to any of claims 3-5 wherein the transceiver unit comprises circuitry which receives multiplexed signals from the base station and at least partially demultiplexes the signals prior to sending at least partially demultiplexed signals to the service units.

7. A remote terminal according to any of the preceding claims wherein said service unit includes circuitry which receives signals from said plurality of subscribers and multiplexes said signals prior to sending said multiplexed signals to said radio transceiver unit.

8. A remote terminal according to any of the preceding claims wherein said service unit includes circuitry which receives multiplexed signals from the radio transceiver unit and wherein the circuitry demultiplexes the signals prior to distributing signals to the plurality of subscribers.

9. A remote terminal according to any of the preceding claims wherein at least one service unit supplies ISDN service to a subscriber.

10. A remote terminal according to any of the preceding claims wherein the at least one service unit supplies data services to a subscriber.

11. A remote terminal for a wireless local loop system comprising:

a radio transceiver unit which receives signals from and sends signals to a base station for connection to a telecommunication network; and

at least one service unit which receives signals from and sends signals via land lines to at least one subscriber, said service unit and said radio transceiver unit being situated at different sites, wherein

said radio transceiver unit and a particular service unit are electrically connected by a single pair of wires which carries at least two of:

(1) telephony signals and signaling in accordance with a standard protocol;

(2) power from the service unit to the radio transceiver unit; and

(3) control and management information indicating at least the status of non-subscriber equipment.

12. A remote terminal according to claim 11 wherein said pair of wires carries at least (1) and (2).

13. A remote terminal according to claim 11 or claim 12 wherein said pair of wires carries at least (1) and (3).

14. A remote terminal according to claim 11 wherein said pair of wires carries at least (2) and (3).

15. A remote terminal according to any of claims 11-14 wherein said radio transceiver unit and a particular service unit are electrically connected by only a single pair of wires.

16. A remote terminal according to any of claim 11-15 wherein the at least one service unit comprises a plurality of service units.

17. A remote terminal according to claim 16 wherein at least two service units are individually powered by energy sources and wherein power for the radio transceiver unit is transmitted to the radio transceiver unit from the service units via a pair of wires from each of a plurality of service units.

18. A remote terminal according to any of the preceding claims wherein the pair of wires is a twisted pair.

19. A wireless local loop system comprising:

at least one remote station according to any of claims 1-18; and

a base station which receives signals from the at least one remote station and passes the signals on to the telecommunication network.

20. A wireless local loop system according to claim 19 wherein the at least one remote station comprises a plurality of said remote stations.

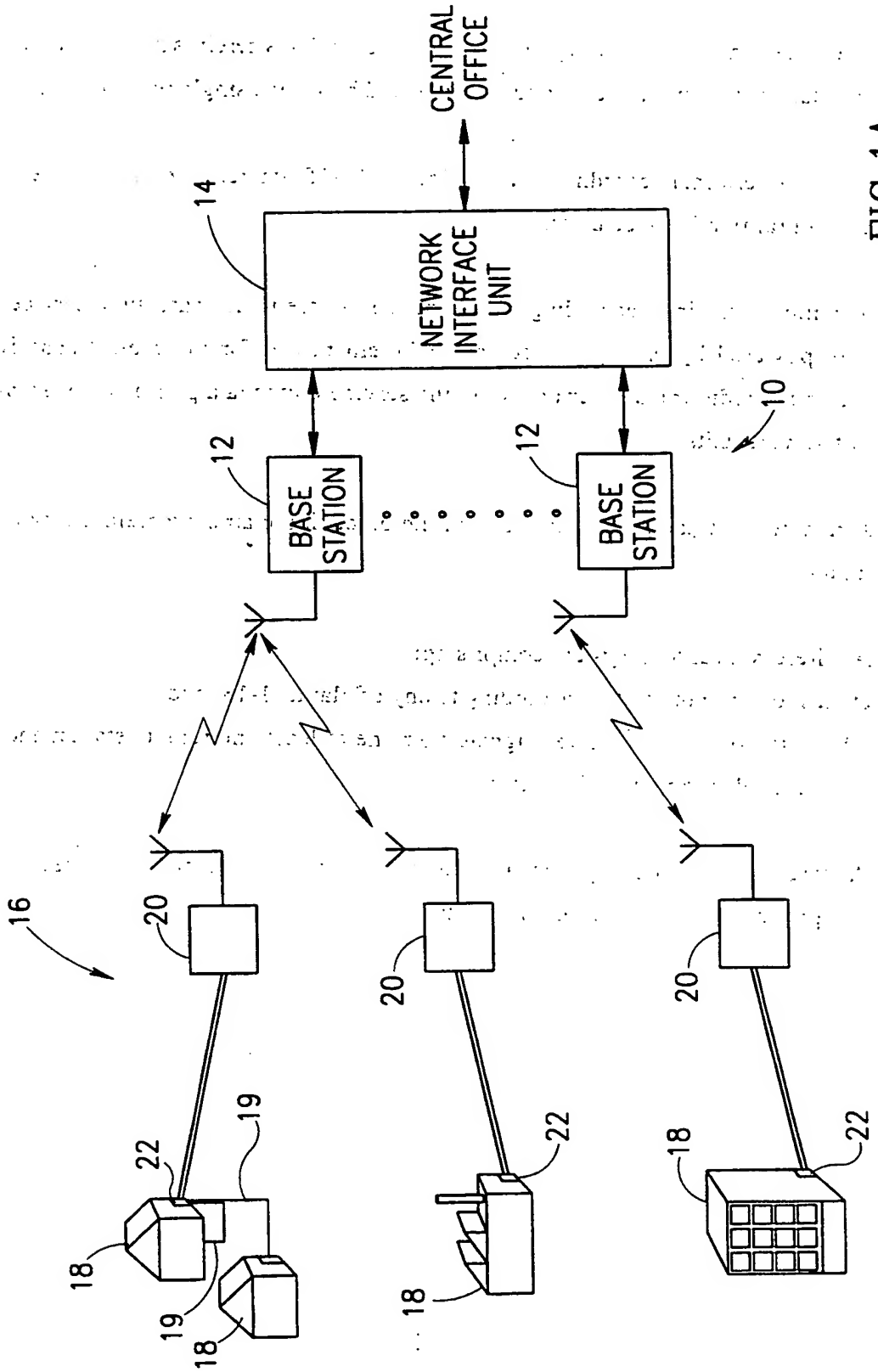


FIG.1A
PRIOR ART

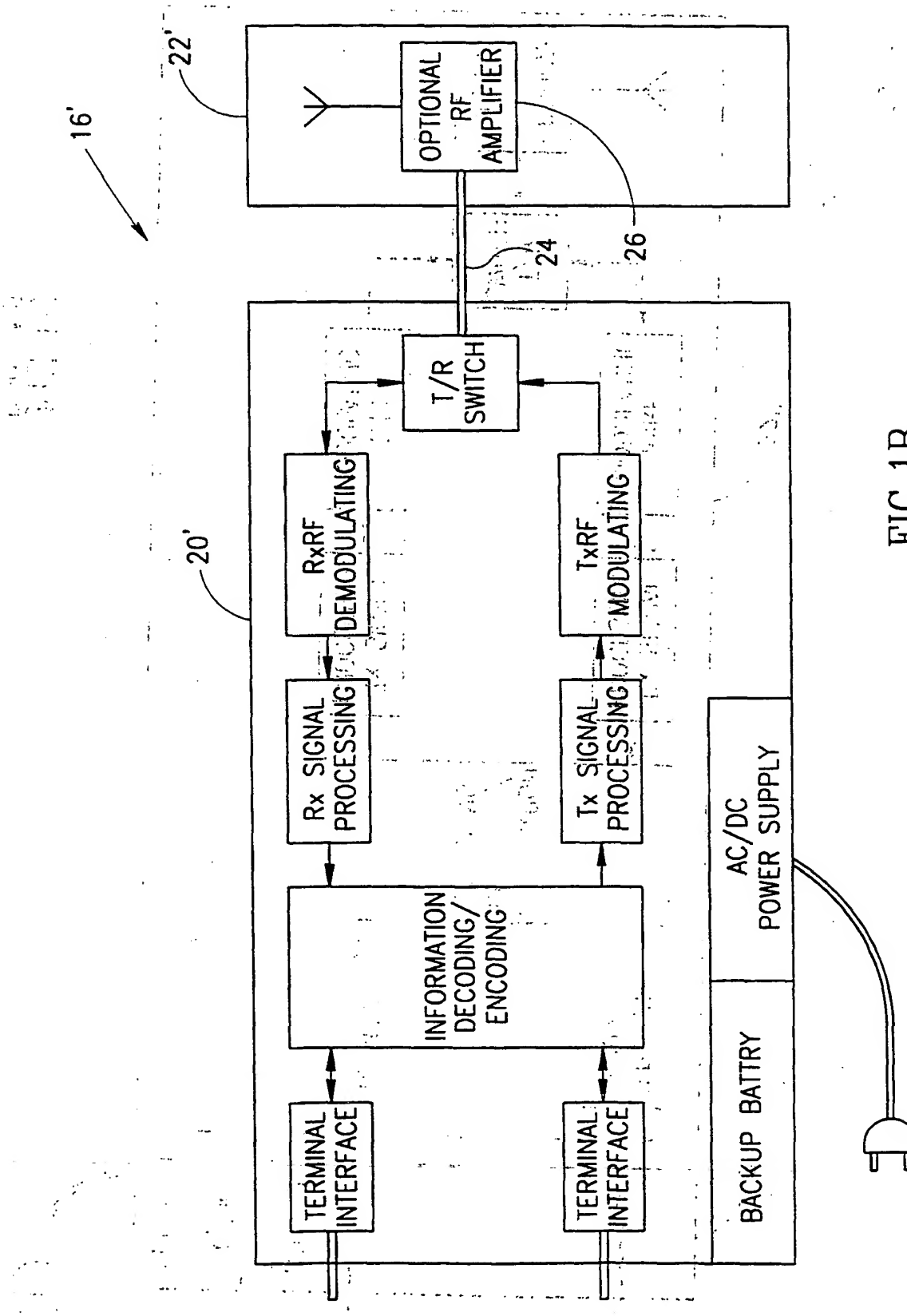


FIG.1B
PRIOR ART

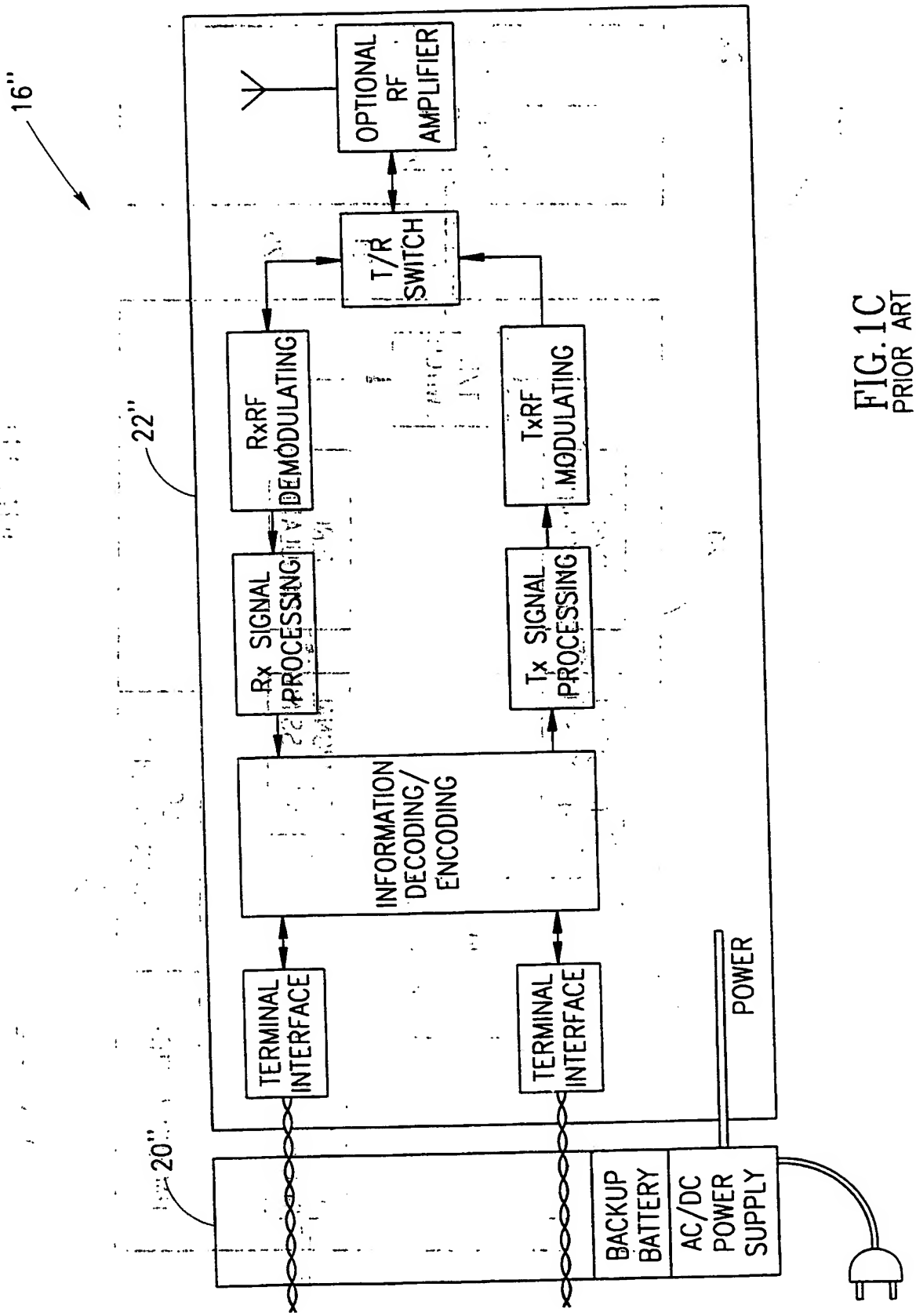
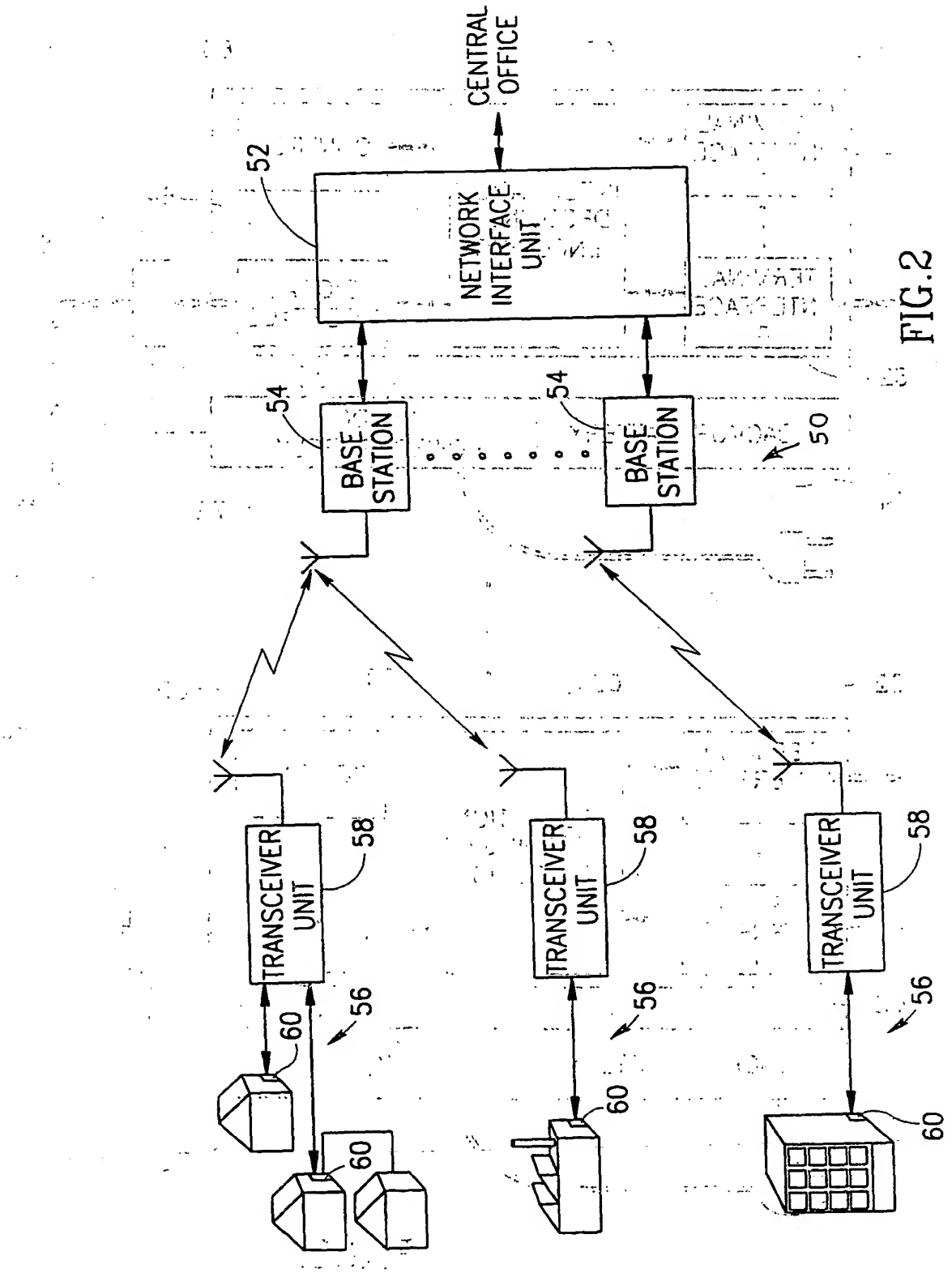


FIG.1C
PRIOR ART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BASE STATION
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BASE STATION
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TRANSCEIVER UNIT
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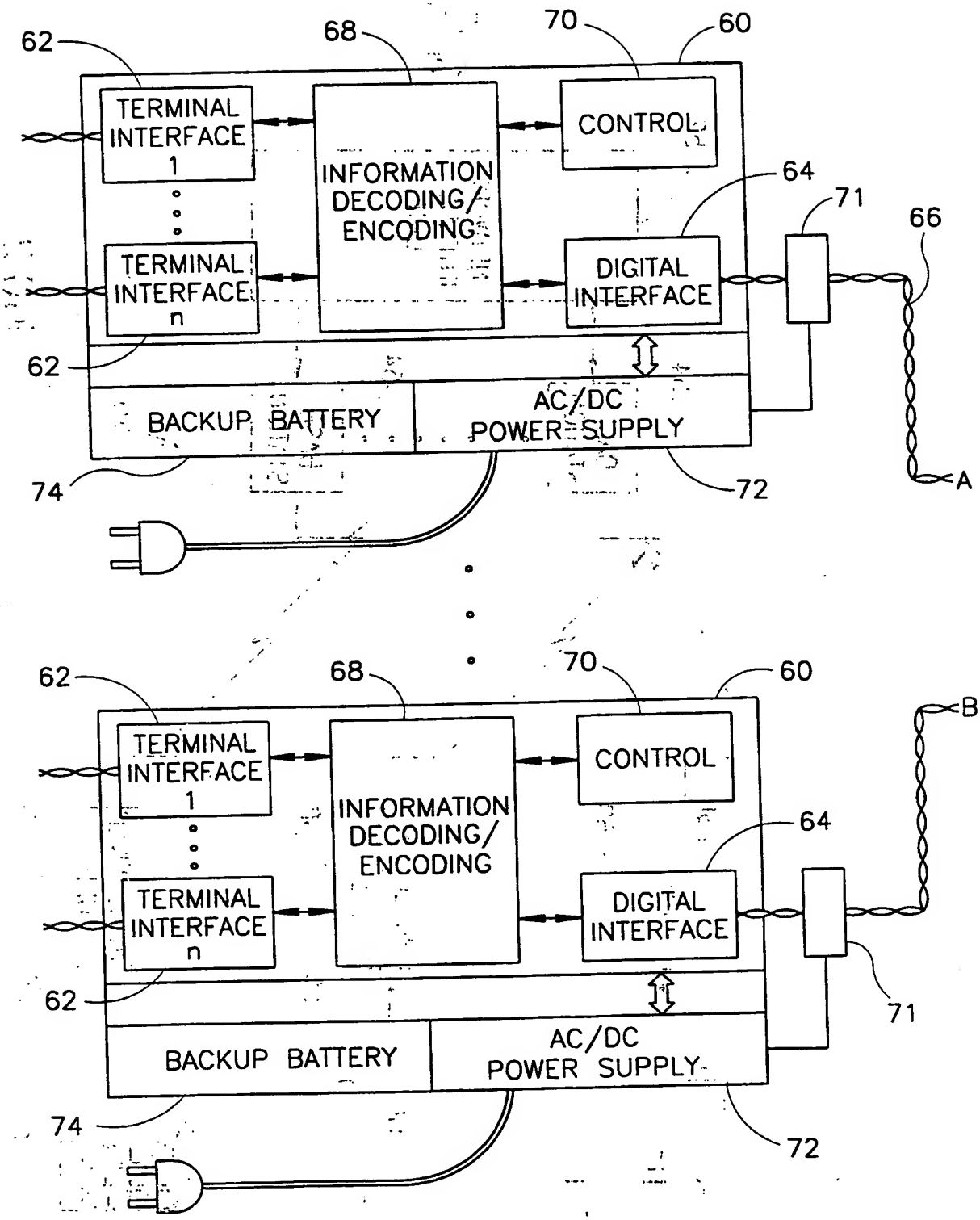
FIG.2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66
DIGITAL INTERFACE
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BACKUP BATTERY
AC/DC POWER SUPPLY
74
72
A
62
68
70
60
B
TERMINAL INTERFACE 1
TERMINAL INTERFACE n
INFORMATION DECODING/ ENCODING
CONTROL
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DIGITAL INTERFACE
62
71
BACKUP BATTERY
AC/DC POWER SUPPLY
74
72

FIG.3A

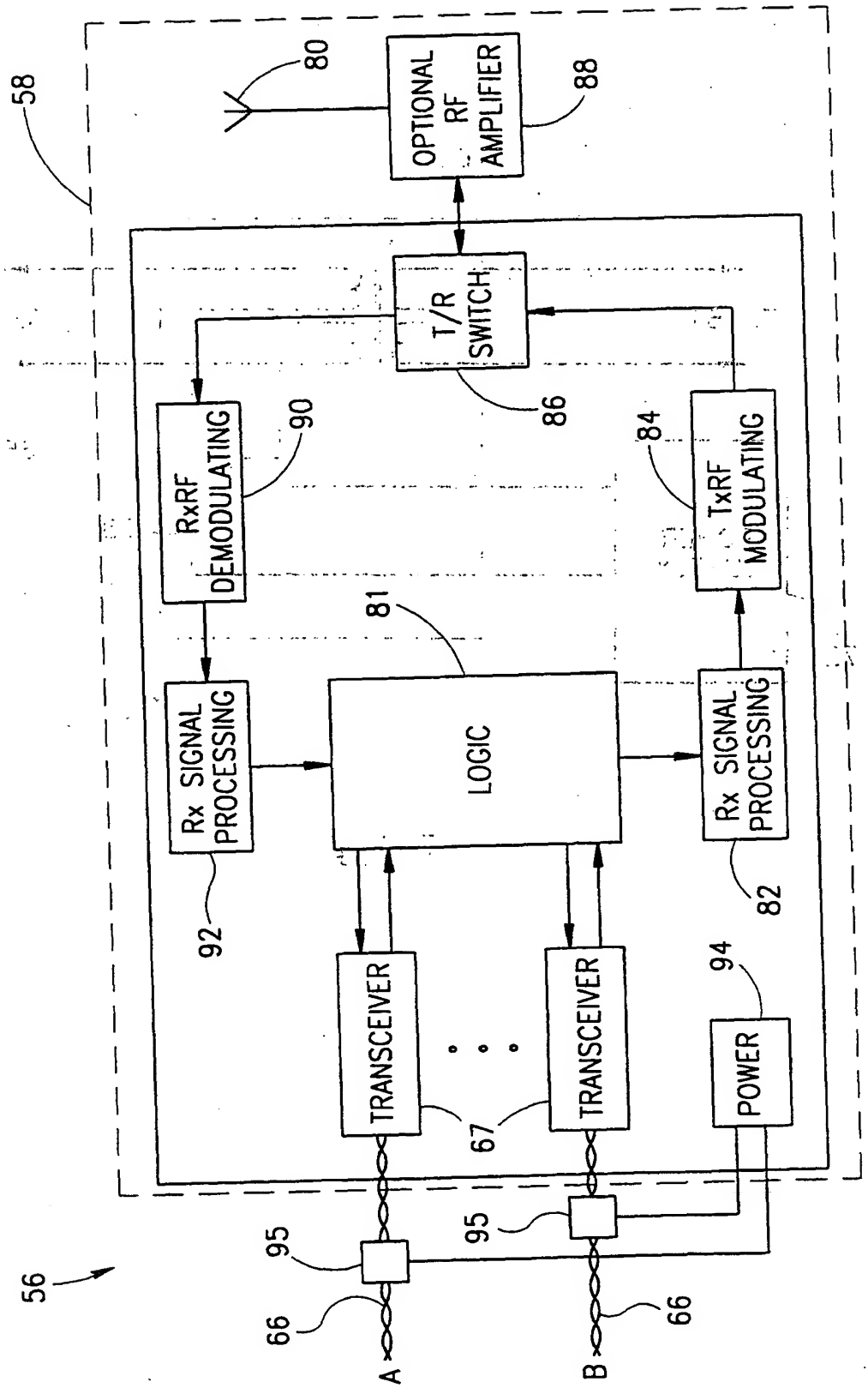
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FIG.3B

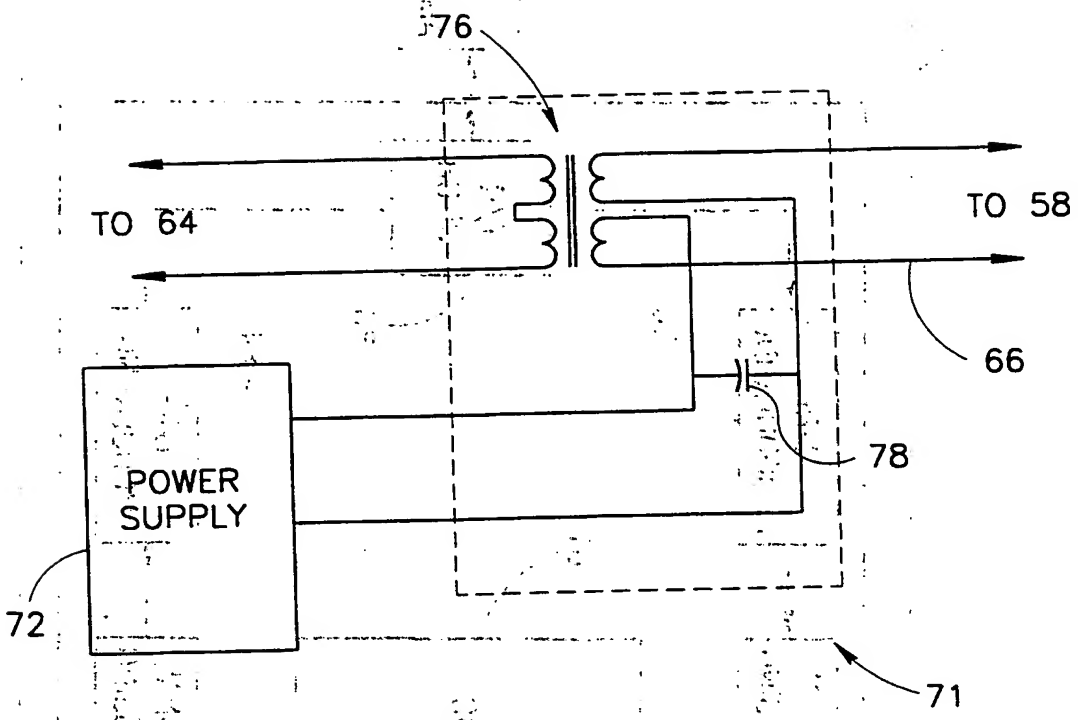

FIG.4

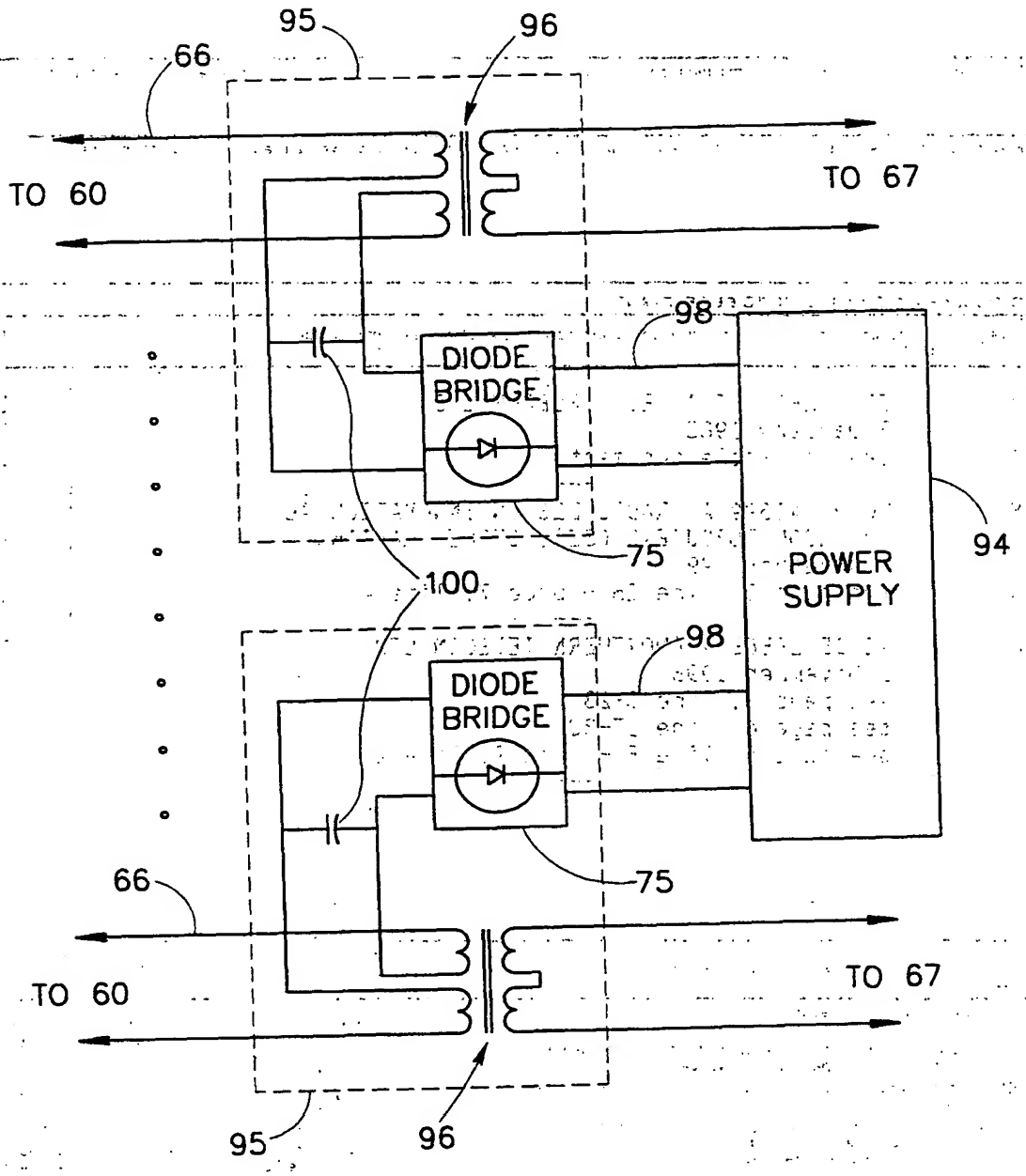
95
96
66
TO 60
TO 67
98
DIODE BRIDGE
75
94
POWER SUPPLY
100
98
DIODE BRIDGE
75
66
TO 60
TO 67
95
96

FIG.5

INTERNATIONAL SEARCH REPORT

Inter onal Application No
PCT/IL 98/00149

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04Q7/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0 251 986 A (ECI TELECOM LTD) 7 January 1988	1-15, 18-20
A	see the whole document	16,17
Y	WO 97 41699 A (RADIO DESIGN INNOVATION AB ;JOHNSON TORBJOERN (SE); STROEM MARTIN) 6 November 1997	1-15, 18-20
A	see page 3, line 25 - page 7, line 4	16,17
A	WO 95 29565 A (NORTHERN TELECOM LTD) 2 November 1995 see page 2, line 3-23 see page 4, line 17-38 see page 6, line 5 - page 9, line 2	1-20

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[X] Further documents are listed in the continuation of box C. [X] Patent family members are listed in annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 February 1999	16/02/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Roberti, V

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INTERNATIONAL SEARCH REPORT

Inter ...nal Application No
PCT/IL 98/00149

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category ³	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	WO 96 01543 A (GENDO LIE ;KARMARGA HARDIENTO (ID); NOLLER COMMUNICATIONS INC (US)) 18 January 1996 see page 25, line 18 - page 29, line 29	1-20

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter onal Application No
PCT/IL 98/00149

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